

# EVOLVING HALO'S BEHAVIOUR TREE AI

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# INTRODUCTION

- We've spent five years living with behaviour trees, and have learned how to optimise them.
- Darwinian approach to choosing features.

**STIMULUS BEHAVIOURS**

BEHAVIOUR MASKS

MAINTAINING KNOWLEDGE

LEFTOVERS

REVIEW

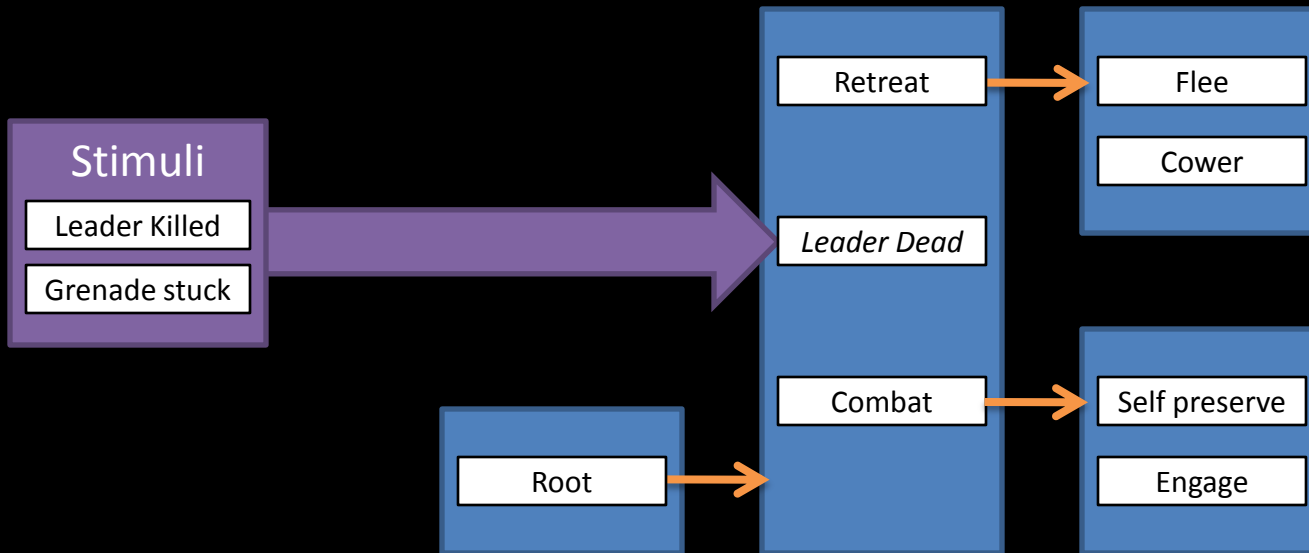


# STIMULUS BEHAVIOURS

- **Problem:** Rare event-driven behaviours tested for every tick.
- **Halo 2:** “Behaviors or impulses dynamically and asynchronously placed into tree at specified location.”



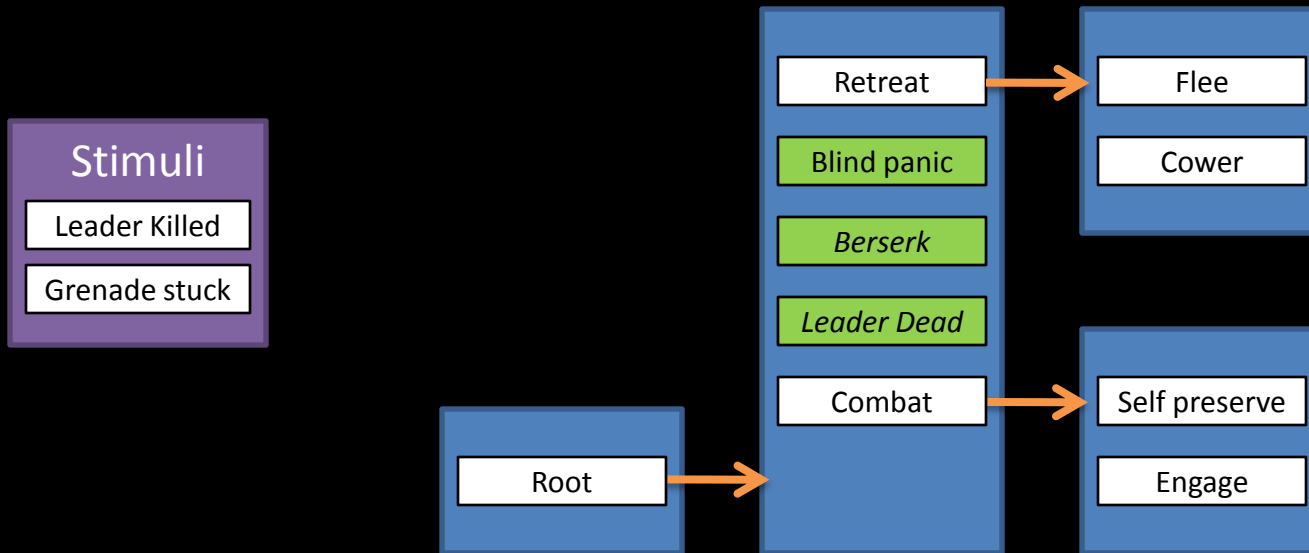
# STIMULUS BEHAVIOURS



- **Problem:** Complicates understanding of behaviour tree, makes it harder to debug the tree, and it's *really* messy to implement.
- **Halo 3:** Cut stimulus behaviours.

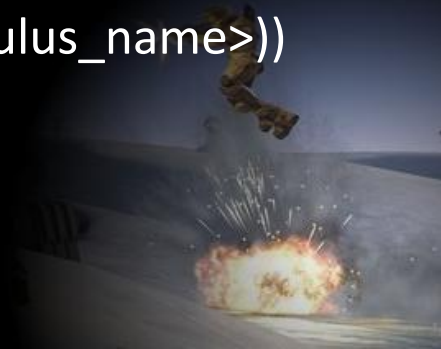


# STIMULUS ACTIVATION



## *Behaviour Group Child Declaration*

`CHILD_ENTRY( <behaviour_name>, CHECK_STIMULUS( <stimulus_name>))`



STIMULUS BEHAVIOURS  
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# BEHAVIOUR MASKS

- **Problem:** Want to be able to remove certain behaviours from the tree in some situations.
- **Halo 2:** Styles were used to mask behaviours.
  - One style per character
  - Open ended designer specified customization



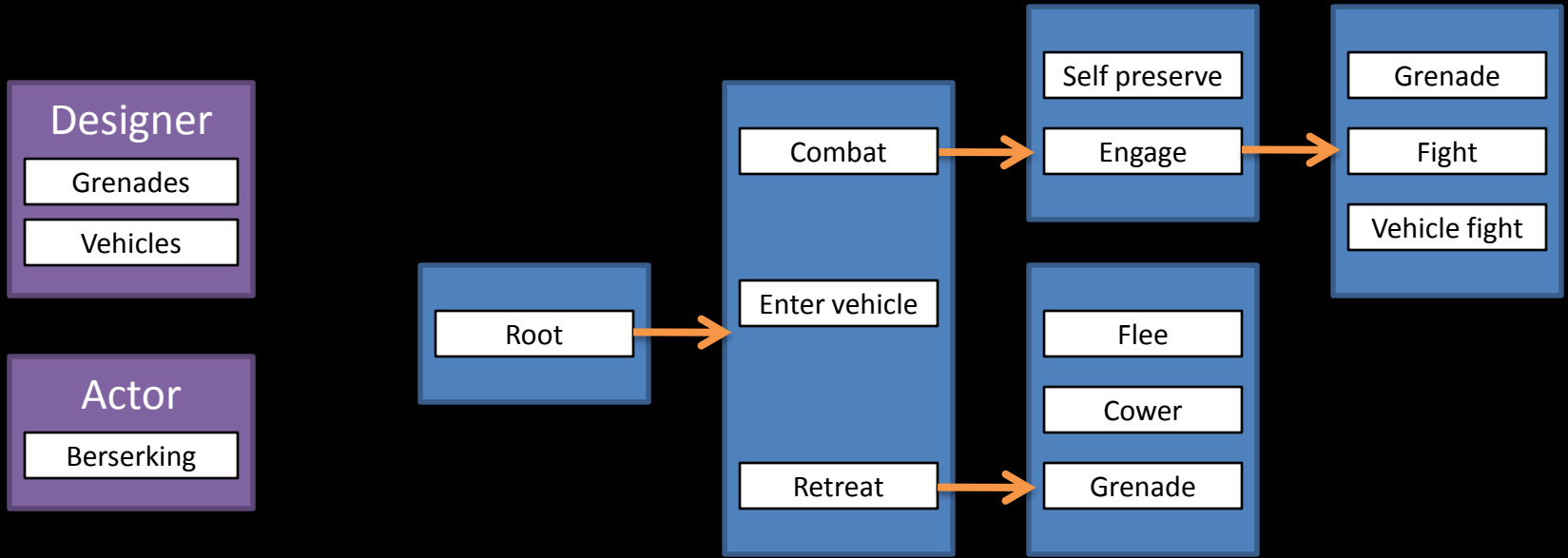


# BEHAVIOUR MASKS

- **Problems:**
  - Designers don't understand the behaviour tree
  - Players don't recognise the subtlety!
- **Halo 3: Give encounters attitude.**
  - “Timid”, “Normal” and “Aggressive” styles
  - Modify behaviour parameters based on attitude



# INHIBITIONS



## *Behaviour Declaration*

BEHAVIOUR( <behaviour\_name>, INHIBIT( <inhibition\_name> | <inhibition\_name\_2>))



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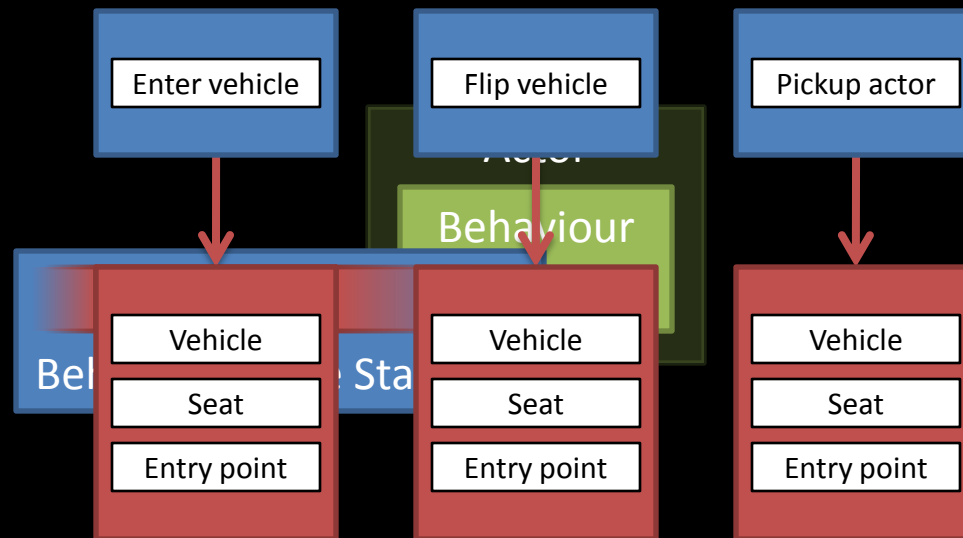
# MAINTAINING KNOWLEDGE

- We have learned what information is appropriate to store in the tree and what is not.
- **Halo 2:**
  - Search state of targets was persistent
  - Vehicle attachment was transient



# MAINTAINING KNOWLEDGE

- **Problem:** Vehicle attachment in stack
  - Forget about vehicle when entry is interrupted
  - Hard to co-ordinate multiple actors



# MAINTAINING KNOWLEDGE

- Introduced vehicle *concept*.
  - The vehicle structure, stored in the actor
  - Attachment and detachment impulses
  - Entry and exit behaviours
- **Benefits:**
  - Much more robust
  - Better overall designer control
  - Tight scripting integration



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# JOINT BEHAVIOURS

- **Problem:** Intelligent AI need to co-operate.
- **Halo 2:** Post invitations to other actors to participate in a *Joint Behaviour*.
- **Halo 3:** Multiple mechanisms
  - Concepts
    - E.g. Vehicle concept and higher level co-ordination
  - Stimuli
    - E.g. Combat synchronisation



# ARGUMENTS TO BEHAVIOURS

- Provide some context in which a behaviour is running.
  - **Cover:** Why am I covering?
- Allow reuse of behaviours.
  - **Post combat:** Goto behaviour.

# IMPULSES FOR CONTROL

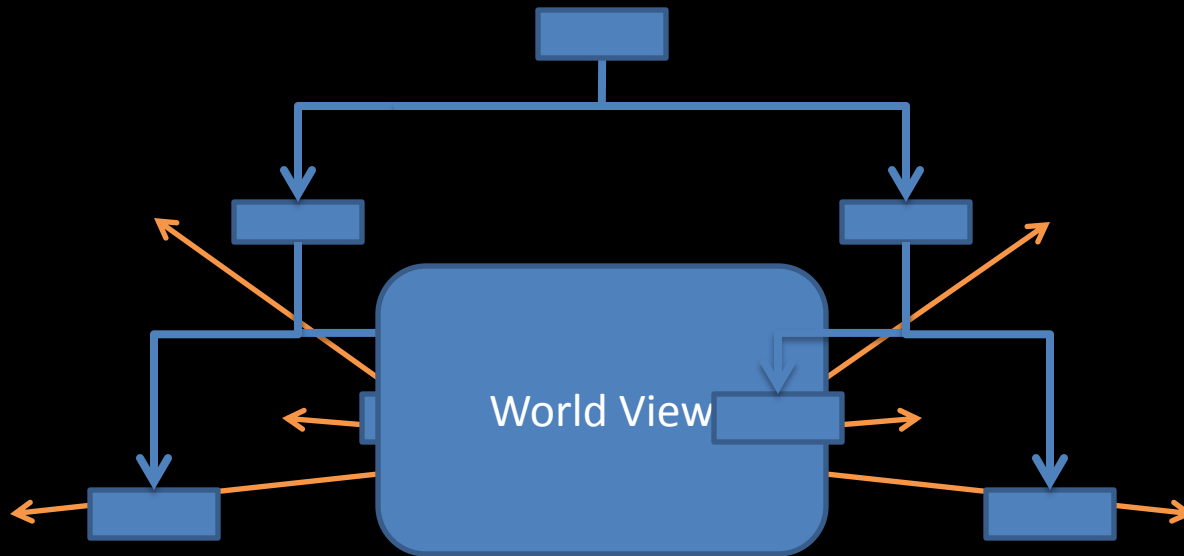
- Growing tendency to use *impulses* to control aspects of the character.
  - Go berserk
  - Turn on active camouflage
  - Control movement speed
- When coupled with behaviour masks, this is very powerful.

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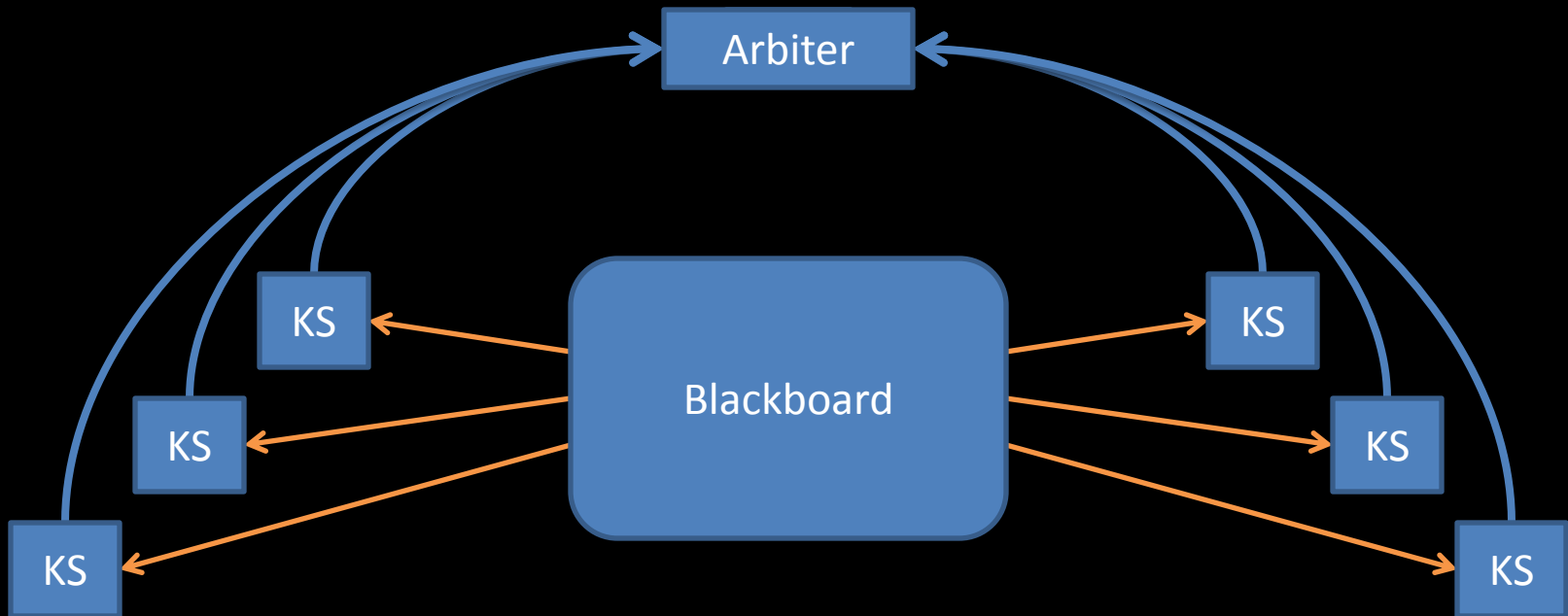
# REVIEW

- Used to be a very *dynamic* behaviour tree.
  - Stimuli inserted new behaviours
- Now it's a static structure with lots of masks.
  - Inhibitions, stimuli, styles
- Moved some concepts out of the tree.
  - Vehicles, posturing

# WHAT HAVE WE CREATED?



# IT'S A BLACKBOARD!



# WHERE NOW?

- Formalise information concepts.
  - Common interface
  - Easier to add new behaviour and perception
- GUI representation.
  - More transparent for designers and debugging

**THE END**

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